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Leaf-litter-dwelling microsnails of Prince Edward Island, Canada (Mollusca, Gastropoda, Eupulmonata)

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Abstract

Samples of leaf litter were collected from 22 woodland sites throughout Prince Edward Island, Canada. Eighty-two specimens belonging to 15 species of litter-dwelling land snails were recovered from 20 of the 22 samples. One-third of the species—*Carychium exile* H.C. Lea, 1842, *Helicodiscus shimeki* Hubricht, 1982, *Strobilops labyrinthicus* (Say, 1817), *Perpolita binneyana* (Morse, 1864), and *Striatura ferrea* Morse, 1864—were previously undocumented in the literature as occurring in PEI. Leaf-litter sampling, even in smaller quantities, is an effective method for finding the often-neglected terrestrial mollusc fauna, which is largely composed of minute species.

Keywords

Atlantic Canada, geographic distribution, land snails, new records

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Introduction

The terrestrial molluscan fauna of the province of Prince Edward Island (PEI), Canada, has received little attention. The earliest mention of a terrestrial mollusc from PEI was of a larger exotic snail, *Helix hortensis*, now *Cepaea hortensis* (O.F. Müller, 1774), in a short communication by Johnson (1906) who noted one locality of this species collected by C. Ives on the island. A year later, Ives (1907) gave a popular account of six species of land snails in a newspaper article appearing in the Prince Edward Island Agriculturalist. Several years later, perhaps the most important publication on PEI land snails was published, a report by Vanatta (1914) on collections made mostly by the botanist Bayard Long of Philadelphia and donated to the Academy of Natural Sciences in that city. Vanatta recorded 24 species, including 22 snails from at least 12 separate places around PEI. From

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PEI, Vanatta newly described *Succinea bayardi* Vanatta, 1914, which Grimm (1975) would later synonymize with *Succinea wilsonii* I. Lea, 1864. Since these early publications, several other authors have mentioned PEI records of terrestrial molluscs, but these most often repeat the earlier records, mainly those of Vanatta (1914): Pilsbry 1919, 1939, 1946, 1948, Dundee 1974, and Nekola and Coles 2010. La Rocque's (1953) catalogue of Canadian Mollusca also gave some indications of the PEI terrestrial mollusc fauna, but often it is not clearly stated if species had been reported from PEI, and instead, generalized ranges were reported for many species. Most recently, McAlpine and Forsyth (2014) documented the occurrence of the introduced *Arianta arbustorum* (Linnaeus, 1758), and Ovaska and Lepitzki (2011) reported the first observation of the native slug *Philomycus flexuolaris* Rafinesque, 1820 on PEI.

However, most published records of terrestrial snails from PEI are of larger species. Microsnails, under 5 mm in their greatest dimension when fully grown, have been mostly overlooked. The publication by Vanatta (1914) is notable as including a larger number of species of microsnails. Remarkably, his publication and Bayard Long's collected materials remain the sole source of information for several species.

In scientific collections, PEI specimens of terrestrial molluscs, especially the smallest species, are not particularly well represented. For microsnails, there are some incidental collections, but the majority appear to have been collected separately in the 1960s and 1970 by Ursula Grigg and F. Wayne Grimm, respectively. Their materials are now split between the Nova Scotia Museum (NSM; Halifax, Nova Scotia) and the Canadian Museum of Nature (CMN; Gatineau, Quebec). Some individual lots collected by Grigg appear to have been split between these institutions, with the latter museum showing Grigg's married name, Thomas.

Leaf-litter samples have been found to be ideal in sampling for litter-dwelling microsnails. In autumn 2014, leaf litter was sampled from 22 woodland sites throughout PEI, and here we report on the species of snail from these collections.

Study Area

Prince Edward Island, at 5,660 km^2, is Canada smallest province. It is one of the three Maritime Provinces and lies in the Gulf of St. Lawrence between latitudes 46 and 47°N. In the Köppen-Geiger system of climate classification, PEI has a Dfb climate: humid continental climate, without dry season and warm summer (Kottek et al. 2006). However, in contrast to the mainland, summer and fall temperatures on the PEI are delayed by the cool, then warm, surrounding waters of the Gulf of St. Lawrence and Northumberland Strait (PEI 2007). The topography of the PEI consists of rolling hills in its central and eastern portions, and low-lying land in the west and along the coast (PEI 2007). The highest point on the island is only 140 m above sea level.

At the time of the first European settlement, roughly 98% of the island was forested, but by 1900 forests amounted to only 30% of their original extent with conversion of land to agriculture (PEI 2010). Much of the present-day forests on PEI have been cut at least once (PEI 2010), and while forests have in general expanded in recent decades, regenerated forests differ from the original (PEI 2010; Curley 2016).

Methods

Twenty-two leaf-litter samples from forest sites were collected in October 2014 by Mark Arsenault, Greg Ridgeway, and Barry Bain (Forests, Fish and Wildlife staff, Government of PEI) while in the field doing other work (Fig. 1; Table 1; Appendix). Mark Arsenault coordinated the sampling, but due to a data loss, the collector of each sample is unknown. Sample locations were chosen at random throughout the day at various locations throughout PEI. The species composition of the tree stand, as noted in the Appendix, was taken from the 2010 Prince Edward Island Corporate Land Use Inventory (PEICLUI 2010).

Leaf-litter samples were randomly collected by hand. Each sample was tightly packed and approximately 1 L in volume. Geographic coordinates were obtained from a hand-held GPS receiver. Samples were frozen, then mailed to RGF, after which each sample was spread out in a shallow pan and allowed to dry at ambient temperature of a garage. Once dry, samples were sieved to remove the coarse woody debris and larger leaves. The remaining fine material was bit-by-bit viewed under a Russian МБС-10 (MBS-10) stereomicroscope and terrestrial snails extracted. In Materials examined, "spec." denotes specimen(s), which are all dry shells. After sorting and identification, this material was deposited in the New Brunswick Museum (Saint John, New Brunswick; NBM, catalogue numbers below). Other museum collections mentioned here are Nova Scotia Museum (NSM), Canadian Museum of Nature (CMNML), and Academy of Natural Sciences of Drexler University, Philadelphia, Pennsylvania (ANSP).

The higher classification (family placement and order of families) follows Bouchet et al. (2017). Specimens were identified to species using Pilsbry (1946, 1948) or literature specifically mentioned for those species in Results.

Results

Eighty-two specimens belonging to 15 species of leaf-litter dwelling land snails were recovered from 20 of the 22 sampled sites (Table 1). Only samples from two sites (PEI.11 and PEI.17) contained no snails. One-third, or five species, were found that were previously not documented from PEI in the literature.

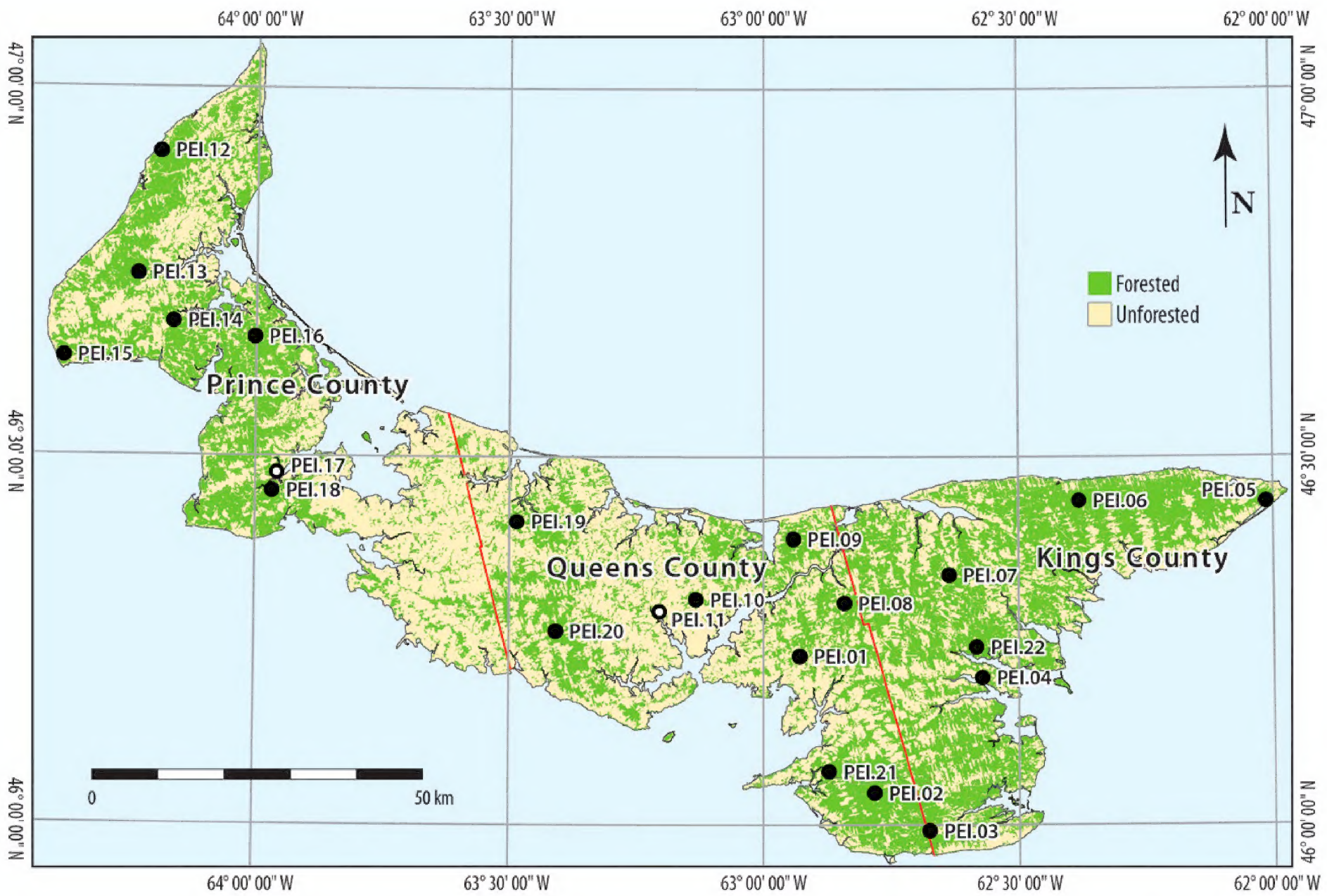

Figure 1. Leaf-litter collection sites on Prince Edward Island : ● = sites with snails; o = sites without snails. Locational data are presented in Table 1 and addition information on stand age and species is presented in the Appendix. Green areas = forested land in 2000 (2000 Forest Outline GIS data © Department of Agriculture and Forestry, Government of PEI).

Table 1. Leaf-litter collection sites on Prince Edward Island. Sites are mapped in Figure 1, and information on stand age and composition at each site is given in the Appendix.

Station	County	Locality	Latitude °N	Longitude °W
PEI.01	Queens	Village Green	46.2295	−062.9295
PEI.02	Queens	Selkirk Road	46.0437	−062.7830
PEI.03	Kings	Hopefield	45.9922	−062.6753
PEI.04	Kings	Brudenell Provincial Park	46.2004	−062.5715
PEI.05	Kings	East Point Road	46.4391	−062.0133
PEI.06	Kings	Mickle Macum Road	46.4406	−062.3809
PEI.07	Kings	Milburn	46.3398	−062.6364
PEI.08	Queens	Campbell Road, Dromore	46.3017	−062.8416
PEI.09	Queens	Old Bedford Road	46.3888	−062.9418
PEI.10	Queens	Confederation Trail, near Union Road	46.3067	−063.1330
PEI.11*	Queens	Sleepy Hollow	46.2901	−063.2046
PEI.12	Prince	Pleasant View	46.9128	−064.1928
PEI.13	Prince	Duvar	46.7469	−064.2349
PEI.14	Prince	Confederation Trail, Coleman	46.6823	−064.1645
PEI.15	Prince	West Point	46.6341	−064.3801
PEI.16	Prince	Conway	46.6615	−064.0028
PEI.17*	Prince	Camp Tamawaby Road	46.4777	−063.9580
PEI.18	Prince	Veteran's Memorial Highway, Days Corner/Wellington	46.4531	−063.9674
PEI.19	Queens	North Granville	46.4119	−063.4851
PEI.20	Queens	South Melville Road	46.2633	−063.4083
PEI.21	Queens	Garfield Road	46.0729	−062.8721
PEI.22	Kings	Royalty Road, Georgetown	46.2419	−062.5828

*No snails found in these samples.

Family Ellobiidae
Genus *Carychium* O.F. Müller, 1774

***Carychium exile* H.C. Lea, 1842**
Figure 2A

New record. CANADA, Prince Edward Island – **Queens County** • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 1 spec., NBM-009889.

Identification. *Carychium* species are recognized by their elongate, whitish-translucent shell having a lamella on the columellar lip. Two species of *Carychium*, *C. exile* and *C. exiguum* (Say, 1822), occur in the Maritimes, but distinguishing between these species can at times be difficult. Shells where the last whorl bulges beyond the plane of the aperture (peristome), "… giving a 'bellied' appearance when viewed from the side" (Clapp in Winslow 1922: 3) are considered to be *C. exiguum*.

Comments. In the NSM collection are specimens collected by U. Grigg (NSM 16835, NSM 17114) which were originally identified as *C. exile*. These instead appear to be *C. exiguum*. Thus, the new record represents the first occurrence data of *C. exile* from PEI. Pilsbry (1948) did not indicate that this species occurs in any Canadian province east of Ontario, although it is known from northern New Brunswick (RGF unpubl. data) and Nova Scotia (MacMillan 1954). Thus, this species is not unexpected from PEI. *Carychium* spp. tend to be quite patchy, generally occurring only at the richest of sites, but the apparent rarity of *C. exile* in this study comes as a surprise.

Family Punctidae
Genus *Punctum* Morse, 1864

***Punctum minutissimum* (I. Lea, 1841)**
Figure 2B

New records. CANADA, Prince Edward Island – **Kings County** • Hopefield [PEI.03]; 45.9922°N, 062.6753°W; X.2014; 1 spec., NBM-009846 • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 1 spec., NBM-009860 – **Queens County** • Garfield Road, Belfast [PEI.21]; 46.0729°N, 062.8721°W; X.2014; 1 spec., NBM-009836 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 20 spec., NBM-009895 – **Prince County** • Conway [PEI.16]; 46.6615°N, 064.0028°W; X.2014; 1 spec., NBM-009834 • Pleasant View [PEI.12]; 46.9128°N, 064.1928°W; X.2014; 4 spec., NBM-009876.

Identification. This is the smallest species of terrestrial snail, when fully grown, in PEI. The shell reaches only 1.1–1.5 mm in diameter (Pilsbry 1948). The combination of small adult size, smoothish teleoconch, and microsculpture of narrow, closely spaced raised colabral threads crossed by weak spiral striae help distinguish this species from others found in this study.

Comments. This species was previously reported from province by Vanatta (1914) as *Punctum pygmaeum* (Draparnaud, 1801), a Eurasian species.

Family Discidae
Genus *Discus* Fitzinger, 1833

***Discus whitneyi* (Newcomb, 1864)**
Figure 2C

New records. CANADA, Prince Edward Island – **Kings County** • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 4 spec., NBM-009862 • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 1 spec., NBM-009899 – **Queens County** • Garfield Road, Belfast [PEI.21]; 46.0729°N, 062.8721°W; X.2014; 1 spec., NBM-009838 • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 2 spec., NBM-009854 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 6 spec., NBM-009894.

Identification. *Discus catskillensis* (Pilsbry, 1896), identified as having shells with a more angular last whorl (Pilsbry 1948), is included here as a synonym of *D. whitneyi*. Partial-COI gene data of typical *D. whitneyi* and *D. catskillensis* morphs shows that these taxa are probably not separable (Salvador et al. 2020; A. Nicolai pers. comm.; R.B. Salvador pers. comm.).

Comments. This is one of the more common terrestrial snails in collections from PEI. It was previously reported from the province by Ives (1907, as *Pyramidula striatella*) and by Vanatta (1914, as *Pyramidula cronkhitei whitneyi*).

Family Helicodiscidae
Genus *Helicodiscus* Morse, 1864

***Helicodiscus shimeki* Hubricht, 1982**

New records. CANADA, Prince Edward Island – **Kings County** • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 7 spec., NBM-009866 – **Queens County** • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 1 spec., NBM-009856.

Identification. Two species of *Helicodiscus* are now known to occur in Canada, although at one time, *H. shimeki* had not been recognized and all material was simply called *H. parallelus* (Say, 1821). Based on partial-COI gene sequence data from other provinces of Canada, the two species are distinct (A. Nicolai pers. comm.). In shell morphology, *H. shimeki* mainly differs from *H. parallelus* by its shallower, more bowled umbilicus (versus steeper-walled in *H. parallelus*; Hubricht 1982), which is nonetheless more difficult to see in less mature shells.

Comments. It is likely that *H. shimeki* was previously reported from PEI by Vanatta (1914) as *H. parallelus*; the two lots in the ANSP from PEI which Vanatta had originally identified are now listed in the ANSP database as *H. shimeki*. In New Brunswick, *H. shimekii* is the most common species of *Helicodiscus*, and it has also been found in Quebec and in Nova Scotia (RGF unpubl. data). Thus, its presence on PEI was not unexpected.

Figure 2. Some leaf-litter dwelling microsnails of Prince Edward Island. **A.** *Carychium exile* from South Melville Road, Brookvale, Queens County (NBM-009889). **B.** *Punctum minutissimum* from South Melville Road, Brookvale, Queens County (NBM-009895). **C.** *Discus whitneyi* from East Point Road, Kings County (NBM-009862), not fully grown. **D.** *Cochlicopa lubrica* from Brudenell Provincial Park, Kings County (NBM-009869). **E.** *Strobilops labyrinthicus* from South Melville Road, Brookvale, Queens County (NBM-009888). **F.** *Zoogenetes harpa* from Mickle Macum Road, Bear River/St. Margaret's, Kings County (NBM-009844). **G.** *Vertigo cristata* from Selkirk Road, Queens County (NBM-009887). **H.** *Striatura exigua* from North Granville, Queens County (NBM 009850). **I.** *Striatura ferrea* from Selkirk Road, Queens County (NMB-009882). **J.** *Striatura milium* from North Granville, Queens County (NBM 009849). All scale bars = 1 mm.

Family Cochlicopidae
Genus *Cochlicopa* A. Férussac, 1821

***Cochlicopa lubrica* (O.F. Müller, 1774)**
Figure 2D

New records. CANADA, Prince Edward Island – **Kings County** • Brudenell Provincial Park [PEI.04]; 46.2004 °N, 062.5715°W; X.2014; 1 spec., NBM-009869 • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 2 spec., NBM-009902 --**Queens County**• -South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 2 spec., NBM-009890. **Prince County** • Conway [PEI.16]; 46.6615°N, 064.0028°W; X.2014; 1 spec., NBM-009835

Identification. *Cochlicopa* species are recognized by their very smooth, shiny, and translucent, elongate-fusiform shells. Some materials in the CMNML and NSM collections have been determined as either of two species, *C. lubrica* or *C. lubricella* (Porro, 1838). However, these materials are not convincingly *C. lubricella*-like, and there are also taxonomic considerations that lend doubt to the effective separating *C. lubrica/C. lubricella* by shell characters (Armbruster 1997).

Comments. *Cochlicopa lubrica* was previously recorded from PEI by Vanatta (1914). This is a common species, which especially abundant in disturbed habitats on the island (RGF pers. obs.).

Family Strobilopsidae
Genus *Strobilops* Pilsbry, 1893

***Strobilops labyrinthicus* (Say, 1817)**
Figure 2E

New record. CANADA, Prince Edward Island – **Queens County** • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 21 spec., NBM-009888.

Identification. *Strobilops* species are recognized by their conical, ribbed shells, which bear lamellae within the last whorl, including in immature shells. Three species occur in Canada (Pilsbry 1948), which are distinguished by the combination of size and shape of their shells, as well as differences in the internal folds within the last whorl (Forsyth and Oldham 2014). PEI shells correspond to *S. labyrinthicus* based on those characters.

Comments. *Strobilops labyrinthicus*, the only common *Strobilops* in Canada, is likely the only species of its genus in the Maritimes (Forsyth and Oldham 2014). Although Pilsbry (1948) did not report this species from any province east of Quebec, it is known from New Brunswick (Bailey 1903; Reigle and Herrington 1967; Forsyth and Oldham 2014) and Nova Scotia (MacMillan 1954; Dimelow 1963; Davis 1985; Forsyth and Oldham 2014). In the NSM collection, there is one specimen from Port Mill [= Hill] Station Road collected by U. Grigg in 1967 (NSM 14851). This and the newly collected specimens represent the only records of this species in PEI. Its presence in only one of the leaf-litter samples is surprising.

Family Valloniidae
Genus *Zoogenetes* Morse, 1864

***Zoogenetes harpa* (Say, 1824)**
Figure 2F

New records. CANADA, Prince Edward Island – **Kings County** • Mickle Macum Road, Bear River/St. Margaret's [PEI.06]; 46.4406°N, 062.3809°W; X.2014; 4 spec., NBM-009844 • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 1 spec., NBM-009861 • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 13 spec., NBM-009900 • Royalty Road, Georgetown [PEI.22]; 46.2419°N, 062.5828°W; 2014; G. Ridgway leg.; 16 spec., NBM-009829 – **Queens County** • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 1 spec., NBM-009855 • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 1 spec., NBM-009885 • Village Green [PEI.01]; 46.2295°N, 062.9295°W; X.2014; 6 spec., NBM-009910.

Identification. This very distinctive species is readily recognized by its conic-ovate shell bearing prominent, lamellar colabral riblets, except on the earliest whorls or when eroded off. No other species resembles it in Canada.

Comments. Vanatta (1914, as *Acanthinula harpa*) reported this species from Campbell's Pond, Darnley, and on PEI this is a common species based on materials in the NBM and CMNML collected since the 1960s.

Family Vertiginidae
Genus *Vertigo* O.F. Müller, 1774

***Vertigo cristata* Sterki in Pilsbry, 1919**
Figure 2G

New records. CANADA, Prince Edward Island – **Queens County** • Campbell Road, Dromore [PEI.08]; 46.3017°N, 062.8416°W; X.2014; 3 spec., NBM-009841 • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 2 spec., NBM-009904 – **Queens County** • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 9 spec., NBM-009853 • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 4 spec., NBM-009887 – **Prince County** • West Point [PEI.15]; 46.6341°N, 064.3801°W; X.2014; 1 spec., NBM-009859 • Pleasant View [PEI.12]; 46.9128°N, 064.1928°W; X.2014; 1 spec., NBM-009878.

Identification. *Vertigo cristata* is recognized from other *Vertigo* species in the Maritimes by the combination of sharply rib-striate sculpture, the relatively short palatal lamellae that together with the parietal lamella and columellar lamella form a cross, the weak or absent sinulus, and lack of a palatal callus, among other characters.

Comments. Nekola and Coles (2010) mapped *V. cristata* with a single dot on PEI. This was likely based on a specimen from Mount Stewart, Queens County (30 July 1912; B. Long leg.; ANSP 106952) reported by Vanatta (1914) as *V. gouldii* but since reidentified as *V. cristata* in the ANSP online database. Specimens of *V. gouldii* in the CMNML collection all were misidentified and are

instead *V. cristata*. These, plus the new records suggest that this is the most common *Vertigo* species in the province. This species is known from all the Atlantic Provinces (Nekola and Coles 2010; own data), and its presence on PEI is therefore expected.

Family Gastrodontidae
Genus *Perpolita* H.B. Baker, 1928

***Perpolita binneyana* (Morse, 1864)**

New records. CANADA, Prince Edward Island – **Kings County** • East Point Road [PEI.05]; 46.4391°N, 062.0133 °W; X.2014; 4 spec., NBM-009864 – **Queens County** • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X. 2014; 2 spec., NBM-009881 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 7 spec., NBM-009891 – **Prince County** • Duvar [PEI.13]; 46.7469°N, 064.2349°W; X.2014; 1 spec., NBM-009831 • Veteran's Memorial Highway, Days Corner/Wellington [PEI.18]; 46.4531°N, 063.9674°W; X.2014; 1 spec., NBM-009871.

Identification. Species of the genus *Perpolita* are recognized by their sculpture of rather widely spaced, incised colabral lines. Slightly smaller, pale-coloured shells were identified as *P. binneyana* and larger, darker specimens as *P. electrina* (Gould, 1841).

Comments. This species has not been previously reported in the literature from PEI. There are seven lots in the CMNML and NSM collections collected between 1966 and 1971. *Nesovitrea binneyana* is not unexpected, as PEI is within the broad continent-wide distribution of this species.

***Perpolita electrina* (Gould, 1841)**

New records. CANADA, Prince Edward Island – **Kings County** • Mickle Macum Road, Bear River/St Margaret's [PEI.06]; 46.4406°N, 062.3809°W; X.2014; 2 spec., NBM-009845 • Hopefield [PEI.03]; 45.9922°N, 062.6753°W; X.2014; 1 spec., NBM-009847 • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 1 spec., NBM-009901 – **Queens County** • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 1 spec., NBM-009884 • Village Green [PEI.01]; 46.2295°N, 062.9295°W; X.2014; 1 spec., NBM-009905.

Identification. See *P. binneyana.*

Comments. This species was previously reported from PEI by Ives (1906, as *Zonitoides electrina*) and Vanatta (1914, as *Vitrina hammonis*). CMNML and NSM collections, as well the new litter-sample and other records show that this is a common species, as expected, on the island.

Genus *Striatura* Morse, 1864

***Striatura exigua* (Stimpson, 1850)**
Figure 2H

New records. CANADA, Prince Edward Island – **Kings County** • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 2 spec., NBM-009903 – **Queens County** • Campbell Road, Dromore [PEI.08]; 46.3017°N, 062.8416 °W; X.2014; 9 spec., NBM-009839 • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 21 spec., NBM-009850 • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 5 spec., NBM-009886 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 19 spec., NBM-009897 • Village Green [PEI.01]; 46.2295°N, 062.9295°W; X.2014; 21 spec., NBM-009907 – **Prince County** • West Point [PEI.15]; 46.6341°N, 064.3801°W; X.2014; 8 spec., NBM-009858 • Veteran's Memorial Highway, Days Corner/Wellington [PEI.18]; 46.4531°N, 063.9674°W; X.2014; 4 spec., NBM-009872 • Confederation Trail, Coleman [PEI.14]; 46.6823°N, 064.1645°W; X.2014; 1 spec., NBM-009873.

Identification. Among the three species of *Striatura* in PEI, *S. exigua* is immediately recognized by its widely spaced lamellar colabral riblets. In this respect, it is superficially more like *Planogyra asteriscus* (Morse, 1857) (Valloniidae), which, however, has even more erect riblets and lacks spiral sculpture on the protoconch, among other characters.

Comments. This species was previously reported from PEI by Vanatta (1914) based on two records. Unpublished older records in NSM and CMNM collections, as well as the new records indicate that this is one of the most common of the litter-dwelling microsnails.

***Striatura ferrea* Morse, 1864**
Figure 2I

New records. CANADA, Prince Edward Island – **Kings County** • Hopefield [PEI.03]; 45.9922°N, 062.6753°W; X.2014; 1 spec., NBM-009848 • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 5 spec., NBM-009863 • Brudenell Provincial Park [PEI.04]; 46.2004°N, 062.5715°W; X.2014; 2 spec., NBM-009868 – **Queens County** • Campbell Road, Dromore [PEI.08]; 46.3017°N, 062.8416°W; X.2014; 5 spec., NBM-009842 • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 1 spec., NBM-009851 • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 5 spec., NBM-009882 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 1 spec., NBM-009892 • Village Green [PEI.01]; 46.2295°N, 062.9295°W; X.2014; 3 spec., NBM-009909. – **Prince County**• Pleasant View [PEI.12]; 46.9128°N, 064.1928°W; X.2014; 1 spec., NBM-009877.

Identification. This species is distinguished by its greyish colour and dull, waxy-appearing lustre; it is quite unlike the two other species of *Striatura*. The microsculpture lacks the strong riblets of the *Striatura exigua* and *S. milium* (Morse, 1859).

Comments. The eight records reported here are the first from PEI; surprisingly, this species has not previously been collected from the province. It appears to be the least common of the three *Striatura* species on PEI, although probably not rare. It is common in New Brunswick and Nova Scotia (RGF unpubl. data).

***Striatura milium* (Morse, 1859)**
Figure 2J

New records. CANADA, Prince Edward Island – **Kings County** • Mickle Macum Road, Bear River/St Margaret's [PEI.06]; 46.4406°N, 062.3809°W; X.2014; 1 spec., NBM-009843 • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 14 spec., NBM-009865 • Milburn [PEI.07]; 46.3398°N, 062.6364°W; X.2014; 13 spec., NBM-009898 – **Queens County** • Campbell Road, Dromore [PEI.08]; 46.3017°N, 062.8416°W; X.2014; 8 spec., NBM-009840 • Confederation Trail, near Union Road [PEI.10]; 46.3067°N, 063.1330°W; X.2014; 1 spec., NBM-009879 • Garfield Road, Belfast [PEI.21]; 46.0729°N, 062.8721°W; X.2014; 3 spec., NBM-009837 • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 25 spec., NBM-009849 • Old Bedford Road [PEI.09]; 46.3888°N, 062.9418°W; X.2014; 2 spec., NBM-009833• Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 9 spec., NBM-009880 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 2 spec., NBM-009896 • Village Green [PEI.01]; 46.2295°N, 062.9295°W; X.2014; 7 spec., NBM-009906 – **Prince County** • Duvar [PEI.13]; 46.7469°N, 064.2349°W; X.2014; 18 spec., NBM-009832 • West Point [PEI.15]; 46.6341°N, 064.3801°W; X.2014; 9 spec., NBM-009857 • Veteran's Memorial Highway, Days Corner/Wellington [PEI.18]; 46.4531°N, 063.9674°W; X.2014; 6 spec., NBM-009870 • Confederation Trail, Coleman [PEI.14]; 46.6823°N, 064.1645°W; X.2014; 3 spec., NBM-009874 • Pleasant View [PEI.12]; 46.9128°N, 064.1928°W; X.2014; 11 spec., NBM-009875.

Identification. This species is distinguished from *S. exigua*, by the more closely spaced and lower colabral riblets, among other characters.

Comments. *Striatura milium* was previously reported from three places on PEI (Vanatta 1914). Unpublished older records, as well as new ones from mostly litter samples, show *S. milium* to be a common, quite ubiquitous, litter-dwelling microsnail in woods on the island.

Genus *Zonitoides* Lehman, 1862

***Zonitoides arboreus* (Say, 1817)**

New records. CANADA, Prince Edward Island – **Kings County** • East Point Road [PEI.05]; 46.4391°N, 062.0133°W; X.2014; 1 spec., NBM-009867 – **Queens County** • Selkirk Road [PEI.02]; 46.0437°N, 062.7830°W; X.2014; 1 spec., NBM-009883.

Identification. This is one of two species of *Zonitoides* in eastern Canada. *Zonitoides arboreus* can best be distinguished from *Z. nitidus* (O.F. Müller, 1774) by differences in body colour; the former is greyish (the head and back are quite dark, and the sides are paler) and the latter is black all over. The shell in *Z. arboreus* is flatter, with less coarse incremental lines, a little smaller.

Comments. This is a common, widespread, frequently woodland-dwelling species that was previously recorded from PEI by Vanatta (1914). Surprisingly, few specimens were found in our samples.

Family Euconulidae
Genus *Euconulus* Reinhardt, 1883

***Euconulus fulvus egenus* (Say, 1825)**

New records. CANADA, Prince Edward Island – **Queens County** • North Granville [PEI.19]; 46.4119°N, 063.4851°W; X.2014; 3 spec., NBM-009852 • South Melville Road, Brookvale [PEI.20]; 46.2633°N, 063.4083°W; X.2014; 1 spec., NBM-009893 • Village Green [PEI.01]; 46.2295°N, 062.9295°W; X.2014; 4 spec., NBM-009908 – **Prince County** • Duvar [PEI.13]; 46.7469°N, 064.2349°W; X.2014; 1 spec., NBM-009830.

Identification. The genus *Euconulus* is represented in Canada by four taxa: *E. fulvus egenus*, *E. alderi* (Gray, 1840), *E. fresti* Horsáková, Nekola & Horsák, 2020, and *E. polygyratus* (Pilsbry, 1899) (Horsáková et al. 2020). Using Horsáková et al.'s (2020) identification key, our PEI specimens differ from *E. polygyratus* in their more conical and more loosely coiled spire, and from *E. alderi* and *E. fresti* in their paler, yellowish- rather than reddish-brown shells, dull rather than glossy surface, and weaker, more closely spaced colabral threads (= "sillons" of Horsáková et al. 2020). Moreover, PEI collections were from upland woods, which is the expected habitat for *E. fulvus egenus*, in contrast to the wetland-dwelling *E. alderi* and *E. fresti*. Mantle pigmentation, while an important diagnostic character (Horsáková et al. 2020), was not used in identifications, as shells were either dead or the animals fully desiccated.

Comments. Although *Euconulus* Reinhardt, 1883 was found by B. Long at Lake Verde and this material is deposited in the collection of the Academy of Natural Sciences of Philadelphia, Vanatta (1914) inexplicably did not report *Euconulus* from PEI.

Discussion

Leaf-litter sampling continues to be shown to be an effective means of finding microsnails that often tend to be overlooked by hand-searching in the field, as already demonstrated elsewhere in Canada (e.g., Forsyth and Lepitzki 2015). Even the relatively small samples collected in this survey were successful in finding presumably rarer species on PEI, or if not rare species, then ones that have not been previously reported from the field. Our samples were collected somewhat "blindly" but with a basic knowledge for what to collect by one of us (MAA), a non-specialist of Mollusca, while undertaking other fieldwork. The collection of leaf-litter samples for microsnails is a technique that can be used for surveying areas opportunistically, as time permits, while in the field for other purposes.

Our sampling sites all had some kind of human intervention within the last century: some had been ploughed agricultural land at one time, many had been clear cut,

some had been managed forest for wood extraction but never ploughed, others had been planted after cutting. The most altered habitats did not necessarily produce the fewest numbers of species. We think that our samples might have been too small to find all species present; species found or not found may be due to random chance. Also of note is that all species found are native—no adventive species were found in our samples.

We did not find evidence of larger snails in our samples, or even juveniles of larger snails. *Cepaea hortensis* (O.F. Müller, 1774) is quite common in PEI but tends to be in open habitats, and species of Polygyridae are apparently absent from PEI, based on historical collections in museums. Polygyrid species are few and rather rare in neighboring provinces of Nova Scotia and New Brunswick (RGF pers. obs.). *Anguispira alternata* (Say, 1817) has been collected in PEI, but last in 1966, and then only from two localities: Curtain [= Courtin] Island and Heron Wood, Bedeque (NSM collection).

Nevertheless, our new data add five species not previously reported from PEI, and we anticipate that additional species will be added with the revision of collections and new field surveys. It is especially noteworthy to consider that the current survey focussed on upland wood habitats. Surveys in other places, such as marshes, fens, swamps, and other wetland habitats would almost certainly find additional, specialist species. For example, we found *Euconulus fulvus egenus* in our samples, but hygric habitats likely harbor one of the wetland *Euconulus* species, such as *E. fresti* Horsáková, Nekola & Horsák (see Horsáková et al. 2020), and several species of *Vertigo* O.F. Müller, 1774 (see Nekola et al. 2018). Additionally, anthropized habitats are expected to harbor unreported introduced gastropods.

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Authors' Contributions

Conceptualization: RC, RGF. Data curation: RGF, MAA. Funding: RC. Investigation: RGF, MAA. Methodology: RGF. Project administration: RC. Resources: RGF, MAA, RC. Validation: RGF. Visualization: RGF. Writing – original draft: RGF, MAA. Writing – review and editing: RC, RGF.

References

Armbruster G (1997) Evaluations of RAPD markers and allozyme patterns: evidence for morphological convergence in the morphotype of *Cochlicopa lubricella* (Gastropoda: Pulmonata: Cochlicopidae). Journal of Molluscan Studies 63: 379–388. https://doi.org/10.1093/mollus/63.3.379

Bailey GW (1903) The land snails of New Brunswick. Bulletin of the Natural History Society of New Brunswick 5 (21): 15–34.

Bouchet P, Rocroi J-P, Hausdorf B, Kaim A, Kano Y, Nützel A, Parkhaev P, Schrödl M, Strong EE (2017) Revised classification, nomenclator and typification of gastropod and monoplacophoran families. Malacologia 61: 1–526. https://doi.org/10.4002/040.061.0201

Curley R (2016) Wildlife matters: an historical overview of public consciousness of habitat and wildlife loss on Prince Edward Island. In: MacDonald E, MacFayden J, Novaczek I (Eds.) In time and a place: an environmental history of Prince Edward Island. McGill-Queens University Press, Montreal, Quebec, Canada / Island Studies Press, Charlottetown, PEI, Canada, 109–139.

Davis DS (1985) Land and freshwater molluscs. Appendix III. In: Morris L (Ed.) The Hayes Cave site, South Maitland, Nova Scotia. Nova Scotia Museum, Curatorial Report 50: 87–91.

Dimelow EJ (1963) Mollusks from hardwoods of the Chignecto Isthmus. The Nautilus 77: 21–23.

Dundee DS (1974) Catalogue of introduced molluscs of eastern North America (north of Mexico). Sterkiana 55: 1–37.

Forsyth RG, Lepitzki DAW (2015) Terrestrial snails (Gastropoda: Pulmonata) from Writing-on-Stone Provincial Park, Alberta, Canada. Check List 11: 1636. https://doi.org/10.15560/11.3.1636

Forsyth RG, Oldham MJ (2014) Distribution of *Strobilops aeneus* Pilsbry, 1926, in Canada, with two new Ontario records (Mollusca: Gastropoda: Strobilopsidae). Check List 10: 397–401. https://doi.org/10.15560/10.2.397

Grimm FW (1975 "1974") A review of *Succinea wilsoni* [sic] a coastal marsh snail of eastern North America. The Nautilus 89: 39–43.

Horsáková V, Nekola JC, Horsák M (2020) Integrative taxonomic consideration of the Holarctic *Euconulus fulvus* group of land snails (Gastropoda, Stylommatophora). Systematics and Biodiversity 18: 142–160. https://doi.org/10.1080/14772000.2020.1725172

Hubricht L (1962) New species of *Helicodiscus* from the eastern United States. The Nautilus 75: 102–107, pls. 107–109.

Ives C (1907) Some notes on the land, fresh water, and marine Mollusca of Prince Edward Island [continued]. Prince Edward Island Agriculturalist 1907 (Saturday, March 30): 6.

Johnson JW (1906) Additional localities for *Helix hortensis*. The Nautilus 20: 95–26.

Kottek M, Grieser J, Beck C, Rudolf B, Ruble F (2006) World map of the Köppen-Geiger climate classification updated. Meteorological Journal 15: 259–263. https://doi.org/10.1127/0941-2948/2006/0130

La Roque, A (1953) Catalogue of the Recent Mollusca of Canada. National Museum of Canada, Bulletin 129: i–x, 1–406.

MacMillan GK (1954) A preliminary survey of the land and freshwater Gastropoda of Cape Breton, Nova Scotia, Canada. Proceedings of the Nova Scotian Institute of Natural Science 23: 389–408.

McAlpine DF, Forsyth RG (2014) Occurrence of the Copse Snail, *Arianta arbustorum* (Helicidae) on Prince Edward Island: an addition to the North American range of a purported potential pest. Northeastern Naturalist 21: N5–N7. https://doi.org/10.1656/045.021.0123

Nekola JC, Coles BF (2010) Pupillid land snails of eastern North America. American Malacological Bulletin 28: 29–57. https://doi.org/10.4003/006.028.0221

Nekola JC, Chiba S, Coles BF, Drost CA, von Proschwitz T, Horsák M (2018) A phylogenetic overview of the genus *Vertigo* O. F. Müller,

1773 (Gastropoda: Pulmonata: Pupillidae: Vertigininae). Malacologia 61: 21–161. https://doi.org/10.4002/040.062.0104

Ovaska K, Lepitzki DAW (2011) New native slug to PEI's list of terrestrial gastropods. Island Naturalist 199: 5–6.

PEI (2007) State of wildlife report – 2007. Forests, Fish and Wildlife Division, Government of Prince Edward Island, Charlottetown, PEI, Canada, 44 + [40] pp. https://www.princeedwardisland.ca/sites/default/files/publications/2007_pei_state_of_wildlife_report.pdf. Accessed on: 2021-9-19.

PEI (2010) State of the Forest Report 2010. Agriculture and Forestry, Forests, Fish and Wildlife Division, Government of Prince Edward Island, Charlottetown, PEI, Canada, 36 pp.

PEICLUI (2010) Prince Edward Island Corporate Land Use Inventory. Resource Inventory and Modelling, Forests, Fish and Wildlife Division, PEI Department Communities, Land and Environment, Charlottetown, Prince Edward Island, Canada. https://data.princeedwardisland.ca/Environment-and-Food/OD0144-Corporate-Landuse-Inventory-2010/tc7z-7rpy. Accessed on: 2022-8-10.

Pilsbry HA (1919) [Pupillidae; Subfamily Gastrocoptinae (continued), Subfamily Vertigininae]. Manual of Conchology, Structural and Systematic, with Illustrations of the Species. Second Series: Pulmonata 25: 65–144, pls. 6–10.

Pilsbry HA (1939) Land Mollusca of North America (north of Mexico), volume I, part 1. The Academy of Natural Sciences of Philadelphia, Monograph 3: i–xvii + 1–573 + i–ix.

Pilsbry HA (1946) Land Mollusca of North America (north of Mexico), volume II, part 1. The Academy of Natural Sciences of Philadelphia, Monograph 3: frontispiece, i–vi + 1–520.

Pilsbry HA (1948) Land Mollusca of North America (north of Mexico), volume II, part 2. The Academy of Natural Sciences of Philadelphia, Monograph 3: i–xlvii + 521–1113.

Reigle NJ, Herrington HB (1967) Localities for New Brunswick land mollusks. The Nautilus 80: 102–105.

Salvador RB, Brook FJ, Shepherd LD, Kennedy M (2020) Molecular phylogenetic analysis of Punctoidea (Gastropoda, Stylommatophora). Zoosystematics and Evolution 96: 397–410. https://doi.org/10.3897/zse.96.53660

Vanatta EG (1914) Land and fresh-water shells from eastern Canada. Proceedings of the Academy of Natural Sciences of Philadelphia 66: 222–226.

Winslow ML (1922) Notes on the internal lamellae of *Carychium*. Occasional Papers of the Museum of Zoology, University of Michigan 128: 1–17.

Appendix

Description of leaf-litter collection sites in Prince Edward Island, with notes on stand age and composition.

PEI.01 This intolerant hardwood stand is along the edge of Confederation Trail on disturbed soils. The area displays as cleared land or regenerating trees in the 1935 aerial photo. The stand is a mix of poplar species (*Populus* spp.), White Spruce (*Picea glauca*), Red Maple (*Acer rubrum*), and White Birch (*Betula papyrifera*).

PEI.02 This intolerant mixed wood stand has been partially cut over the last century. The stand is a mix of Balsam Fir (*Abies balsamea*), White Birch, Red Maple, and poplar species.

PEI.03 This stand has a clear-cut origin that is visible on the 1968 aerial photo. The stand is dominated with White Spruce, Eastern Larch (*Larix larcina*), White Birch, Red Maple, and Balsam Fir.

PEI.04 This stand is on previously ploughed soils which displays as agricultural land on the 1935 aerial photo. The dominant trees are Black Spruce (*Abies mariana*), Red Spruce (*Picea rubens*), poplar, Eastern Larch, and Eastern White Pine (*Pinus strobus*).

PEI.05 This stand is managed forest and displays as clear-cut on the 1935 aerial photo. The 2010 forest inventory shows a mix of Balsam Fir, White Spruce, and White Birch.

PEI.06 This stand has a clear-cut origin that was planted with Balsam Fir in 1993.

PEI.07 This stand is typical of a managed woodlot that may have been harvested several times. The stand is identified as having a clear-cut origin and is mix of Balsam Fir, Red Maple, and White Birch.

PEI.08 This stand is typical of a managed woodlot that may have been harvested several times. The stand is identified as having a clear-cut origin and is mix of Red Maple, Balsam Fir, and White Birch.

PEI.09 This stand is on previously ploughed soils which displays as agricultural land on the 1935 aerial photo. The stand was clear-cut and planted with Black Spruce in 1991.

PEI.10 This stand is typical of a managed woodlot that may have been harvested several times. This mixed softwood stand is dominated by Balsam Fir, White Pine, and Red Maple.

PEI.11 The mixed softwood stand at the back of a farm is characteristic of a managed or second-growth forest that has been harvested for firewood over the centuries but never ploughed. It is dominated by Balsam Fir, Black Spruce, and Red Maple.

PEI.12 This mixed softwood stand is typical of a managed woodlot that may have been harvested several times. It is dominated by Balsam Fir, Eastern Larch, Red Spruce, poplar species, and Red Maple.

PEI.13 This mixed softwood stand is typical of a managed woodlot that may have been harvested several times. It is dominated by Balsam Fir, Eastern Larch, and Red Maple.

PEI.14 This mixed softwood stand is typical of a managed woodlot that may have been harvested several times. It is dominated by Balsam Fir, Red Maple, poplar species, and Eastern Larch.

PEI.15 This mixed softwood stand is typical of a managed woodlot that may have been harvested several times. It is dominated by Balsam Fir, Red Spruce, Red Maple, and White Birch.

PEI.16 This stand is on previously ploughed soils which displays as agricultural land on the 1935 aerial photo. This intolerant hardwood stand is a mix of Red Maple, poplar species, White Spruce, and White Birch.

PEI.17 This stand is on previously ploughed soils which displays as agricultural land on the 1935 aerial photo. The stand was planted with Balsam Fir in 1958.

PEI.18 This mixed softwood stand dominated by Balsam Fir, Black Spruce, and Red Maple has signs of being previously cut.

PEI.19 This mixed softwood stand dominated by White Spruce, Red Spruce, and Balsam Fir is greater than 17 m tall in a low riparian zone area.

PEI.20 This stand is a tolerant hardwood mix with Sugar Maple and Red maple as the dominant trees with White Birch, Balsam Fir, and poplar in the mix. The stand is characteristic of a managed or second-growth forest that may have been harvested for firewood over the centuries but never ploughed.

PEI.21 This intolerant mixed-wood stand is adjacent to an old agriculture field. The stand is identified as having a clear-cut origin and is a mix of Red Maple, White Spruce, Balsam Fir, White Birch, and Pin Cherry (*Prunus pensylvanica*).

PEI.22 This is an Eastern Larch and White Pine plantation established in 1990 on previously ploughed soils which displays as agricultural land on the 1935 aerial photo. The stand was likely established on a clear-cut as trees are evident in the 1968 aerial photo.